Study on Ontology-based Multi-technologies Supported Service-Oriented Architecture

GaiHai Li [a], Gang Huang [b] and Dongli Yang [c] and Qing Hu [d]

Northeast Petroleum University, Daqing 163318, China

[a]13039863165@163.com, [b]huanggangmail@126.com, [c]ydl298@163.com, [d]68817656@qq.com

Keywords: ontology, Web service, semantic.

Abstract. Web service is an emerging distributed computation mode and provides Internet-based software service unrelated to development environment. Such service-oriented calculation mode follows certain architecture, adapts Web environment openness and lays technological base for Web information and application procedure integration. But, existing Web service lacks obvious semantics. Web services cannot well understand information mutually conveyed, hinder service communication and interaction and cannot fulfill automatic service combination. From the perspective of service discovery, keyword-based grammar service discovery cannot ensure accuracy, lack semantic information support and cannot achieve secondary selection from given service candidate set. The key cause of the above problems is that there is lack of sharable semantic platform oriented to Web service. Thus, sharable semantic interpretation of Web service interface and execution process cannot be fulfilled. The setup of semantic platform contributes to improving service discovery quality and laying a foundation for automatic service combination. In allusion to these practical application demands, research status and existing problems, this paper mainly focuses on Web service semantic platform setup to propose Multi-technologies Supported Service-Oriented Architecture (MTSSOA). This architecture regards ontology as the core and take Web service process attribute description and Semantic coordination as assistive technology.

Introduction

Classical Web service architecture. As a new network service mode, Web service receives more and more attention from industrial circles and researchers. Web service is published by individuals or enterprises. Users discover, select and call Web service via Internet. Web service online completes specific tasks and meets user demand. From technical perspective, Web service is the object or component deployed on Web and published in Web site in standard mode for other users or Web application programs to discover and use it.

Web service uses standard protocol and owns high integration ability and intact encapsulation. It provides a loosely coupled distributed computing environment. Web service users only care for its functions, and do not take into account of its internal implementation mechanism. Web service shields the application platform at the bottom layer and owns favorable platform independence. The use of standard protocol lays the foundation for mutual operations among services so that Web application breaking away from software platform can be integrated. Thus, Service-oriented Architecture (SOA) is a component model which connects different functional units (called services) of application program through well-defined interface and contract among these services. Standard architecture of current classical Web service is shown in Fig.1.

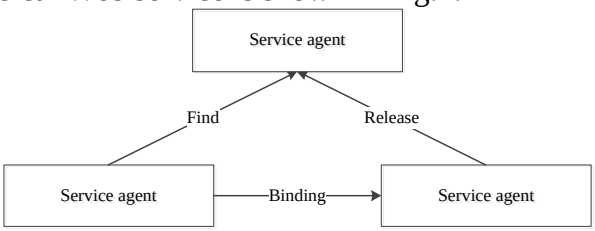

Fig.1 Classical SOA architecture

Classical Web service architecture gives Web service role and basic protocol which can satisfy service publication, query and binding. Therefore, main contribution of classical SOA architecture is to appoint basic protocol so as to break away from software platform and fulfill software sharing and mutual operation in open Web environment, open a new mode for software development and application, further improve component thought and respond to Web environment characteristic.

At present, semantic extension study aiming at SOA architecture has become a hotspot of Web service research. For example, BALES [1] is a classical Web service selection method based on semantic matching. It uses WordNet ontology to gain sharable interpretation in the domain. On the contrary, it is a shareable vocabulary set describing services. Semantic distance can be calculated through synonyms and hyponymy of ontology word as well as other attributes. DAML-S provides a upper-layer ontology to carry out semantic description of services, including function and quality limit description. IBM puts forward WSLA (Web Service Level Agreements) in allusion to QoS. It is SLA description based on XML [2]. WSOL (Web Service Offerings Language) also supports formal specification of various limits [3]. Literature [1, 3] proposed WEB service framework service framework supporting QoS. It supports QoS verification, but fails to give good definitions for other architectures or give detailed verification process of QoS. Literature [4] puts forward a service discovery model which includes functional requirement and non-functional requirement (such as quality) of Web service. This model aims to prove the quality declared by service providers and provide confirmed service quality to service consumers. CB-SeC [5] framework is an Agent-based architecture. This architecture calculates and grades Web services according to Consumer information and service environment, and selects services according to grading. Aura architecture [6] models for user tasks. User tasks adjust as environment changes. Meanwhile, when users' positions change, Aura system will transfer to new environment form original environment. Literature [7] applies context WIDGET to collect context information from the sensor, gathers and explains the information collected for application programs to subscribe and use.

Multi-technologies Supported Service-Oriented Architecture.

In view of such environment characteristics of Web as openness, dynamic and distributed type, this paper puts forward ontology-cored MTSSOA (Multi-technologies Supported Service-Oriented Architecture).

As shown in Fig.2 in MTSSOA, service registration center is a memory pool for service and data description. Service providers publish services through service registration center, while service users discover or look up services available through service registration center. QoS database and context pattern library are dynamic. After a service us called and executed, they feedback maintenance information. Service quality evaluation and context pattern are synthesized through historical data of services. For example, QoS evaluation data come from synthesized service providers' static self-evaluation and dynamic evaluation of service execution. Service quality evaluation and context pattern library are important parameters for objective service evaluation and can boost accuracy for users' service selection. To introduce quality and context information, it is necessary to modify original three basic protocols so as to better and more comprehensively achieve service description, discovery and binding.

MTSSOA architecture adds multi-Agent semantic coordination based on ontology library. This ontology library provides service ontology and Agent conversational language. Under distributed environment, this ontology is called local (or partial) ontology. Higher-level semantic shared space is created through distributed ontology fusion algorithm. Service description link adds dynamic properties description which mainly aims at service execution process.

Service provider is an application program, a software module or another service needing a service. In MTSSOA architecture, service users communicate and discuss through Agent and service registration center as well as service providers. This architecture adopts conversational language library and domain ontology library to support communication and coordination among Agent.

Service users complete service query at registration center, transmission binding service and exaction service through Agent. Service users are responsible for feeding back QoS and context information.

Service provider is an entity whose address can be searched visa network, receives and executes users' request with the help of Agent. It publishes services and interface contract to service registration center so that service users can discover and visit the services.

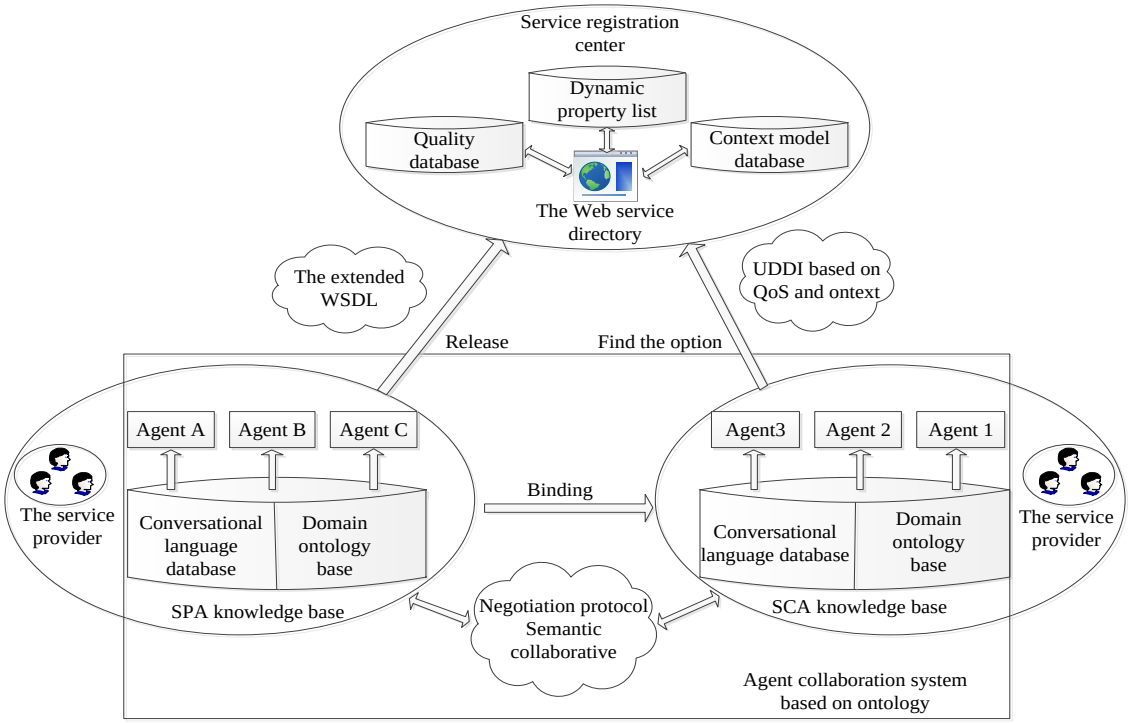

Fig.2 Multi-technologies Supported semantic Web service-oriented architecture

MTSSOA extends three basic protocols in order to achieve functional appreciation for service description, discovery and selection. Agent coordination improves automation ability of service selection. On the one hand, establishment of Web service ontology and especially quality and context ontology provides knowledge base for Agent communication and coordination; on the other hand, it loads semantic information for Web service and mainly solves two problems: 1) define QoS ontology and context ontology, and fulfill insertion and transmission of QoS and context information in SOAP; 2) provide distributed knowledge base integration method oriented to Agent coordination. Compared with existing Web service description, discovery, selection and calling methods, MTSSOA overall considers semantic information of Web service description, selection quality and context factor and satisfies uses' customization and individual needs. Semantic coordination with multi-Agent system (MAC) simplifies man-machine interaction, and improves efficiency and accuracy of Web service discovery, selection, binding and calling.

Service ontology and semantic coordination in MTSSOA.

Semantic organization and description of Web service is a prerequisite for achieving Web service discovery, execution and combination automation. Interaction and inference among heterogeneous information systems need mechanical understanding of formal semantics of information, rather than pure understanding of symbols used to express information. In MTSSOA model, ontology is knowledge base framework supporting Agent and also semantic support of Web service.

In Web service research domain, each Web service is related to service domain, interface, quality and execution. Quality and context are important components of service ontology oriented to service selection. Service quality is from users' perspective. Users here are not the people in general meaning, but the programs sending request. In MTSSOA, this program refers to Agent. For service providers, QoS factors of services which must be considered include availability, safety, response time and throughput capacity etc.

The concept of Context is widely applied in different domains, but the definition of Context is given according to certain environment and application. Due to different application domains and tasks, the definition and usage of context are also diverse. In Web service domain, context generally contains client context and service operation context. Client context is demand-oriented and is closely related to service discovery and selection task. Server-side context refers to service operation environment. Usually, service operation context is perceived in real time through service provider Agent. This paper adopts Agent as service agent and service user agent. Here, context is Agent-oriented. Agent perceives environment and executes corresponding behaviors according to environment. For service consumption agent, context is all information about consumption client of Web service. The information can be used to adjust Web service execution and output. The final purpose is to meet consumers; customization and individual needs. It contains client environment, object and condition etc. Context ontology is abstract and organization form of context pattern library in the above models. Context information executed by the service is kept in pattern database through feedback. It is kept as an example.

From the perspective of life cycle, Context information generates at the client and is inserted in SOAP message. When message is transmitted to Web service registration center, service discovery and selection including context information are conducted. Service binding and execution are completed under context condition. A complete selection, call and execution as well as context information as feedback data to expand context pattern library.

When service selection and context pattern library expand, client context needs transmitting. Context is loaded in SOAP message for transmission. In this way, Web service can receive or send context data. In addition, in dynamic and open Web environment, since interactive Web services and their characteristics cannot be confirmed in advance, service coordination also becomes increasingly complex. Services cannot reach a shared model, protocol and exchange data type in advance, so information exchange, query and request must be conducted on the basis of common semantics. For the convenience of coordination and misoperation prevention, appropriate individuals sharing language description, time and situation are needed. Although Tuple Space coordination model can be used for traditional entity coordination, there is very strong limitation in isomerous environment. It cannot provide communication-oriented semantic support.

Tuple spaces coordination model is fused with semantic Web technology URI, name space, RDF, RDF Schema, OWL DL and SWRL. MTSSOA introduces collaborative middleware Semantic Web Tuple spaces (SWTs) with semantic perception ability. In open and dynamic distributed system, SWTs cannot just serve as warehouse of semantic information, but isomerous collaborative entity can reach communication and coordination purpose through sending and retrieving semantic information under target, space and time decoupling via SWTs.

Conclusions

This paper provides MTSSOA which carries out semantic extension of SOA. It regards ontology as main semantic support technology and overall considers QoS of services, context and dynamic attribute description. On this basis, Tuple Space is introduced as primary technology of semantic coordination. This paper gives details of MTSSOA. The introduction of QoS database, context pattern library list enriches service description contents, which can serve as the basis of service discovery and selection evaluation. This paper achieves loading of context information in SOAP message and provides Web service ontology architecture including QoS and context. In MTSSOA, semantic sharing (including static semantics and operation semantics) in distributed environment is a core problem. Considering MTSSOA cannot break away from open Web environment, the author will carry out in-depth study on semantic coordination.

Acknowledgements

This work was supported by the Provincial Department of Education of Heilongjiang province under Grant Nos”12541087”

References

[1] DAML-S Coalition, DAMLS-S, Web Service Description for the Semantic Web,[C] In Proceeding of the International Semantic Web Conference, June 2002.

[2] A. Keller and H. Ludwing, the Web Services SLA Framework: Specifying and Monitoring Service Level Agreements for Web Services[R], IBM Research Report, May 2002.

[3] V. Tosic, B. Pagurek, K. Patel, WSOLA Language for the Formal Specification of Classes of Service for Web Services[C], International Conference on Web Services, Las Vegas, Nevada, USA, June 2003.

[4] M. Tian, A. Gramm, T. Naumowicz, H. Ritter, J. Schiller, A Concept for QoS Integration in Web Services[C] 4th International Conference on Web Information Systems Engineering, Rome, Italy, December 2003

[5] Hongan Chen, Tao Yu, Kwei-Jay Lin, “QCWS: an implementation of QoS-capable multimedia web services”[C] IEEE Fifth International Symposium on Multimedia Software Engineering, December 2003

[6] S. K. Most´efaoui and G. K. Most´efaoui. Towards A Contextualisation of Service Discovery and Composition for Pervasive Environments[C]. In Proc. of the Workshop on Web-services and Agent-based Engineering (WSABE), 2003.

[7] J. P. Sousa and D. Garlan. Aura: an Architectural Framework for User Mobility in Ubiquitous Computing Environments[C]. In Proc. of the Working IEEE/IFIP Conf. on Software Architecture (WICSA), p29–43, 2002.